

Prospective Comparative Study of Lumbar Sequestrectomy and Microdiscectomy

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Key words

- sequestrectomy
- microdiscectomy
- disc herniation
- lumbar spine
- reherniation

Abstract



Introduction: During microsurgical disc operation, usually a sequestrectomy and a nucleotomy are performed. Whether a nucleotomy is necessary in any case is disputed. The aim of this study is to examine this question on the basis of clinical results and to compare rates of recurrence between the two groups.

Methods: A prospective analysis was performed in 100 patients with sequestrectomy and the first 100 consecutive patients with microdiscectomy out of a cohort of 1245 patients, who were operated by six surgeons between 2003 and 2006. The study is designed with special emphasis on the actual pain status, the functional capacity and recurrence.

Results: Despite more comorbidities the hospitalization was significantly shorter in the sequestrectomy-treated group. This group revealed more favourable results on pain scales

(VAS visual analogue scale). The percentage of back pain in the discectomy-treated group was significantly higher. This went along with a significantly higher consumption of painkillers. At follow-up (34 months after surgery on average), there were no differences in the activities of daily live, measured by patient's questionnaires (ODI Oswestry low back pain disability questionnaire). Complete questionnaires were available for 46 of the sequestrectomy patients, and for 45 of the discectomy patients. Early reherniation occurred in two patients after discectomy and late reherniation in one patient after sequestrectomy.

Conclusions: Sequestrectomy alone is a safe operative modality. Sequestrectomy does not seem to entail a higher rate of recurrences compared with microdiscectomy and the results are as favourable as or better than results after discectomy.

Introduction



The introduction of microsurgical techniques in 1977 and 1978 by Yasargil [1] and Caspar [2] represented an important evolution in lumbar disc surgery. Today, microsurgery is considered a standard procedure. However, clinical results were comparable to procedures with larger surgical approach [3]. Nevertheless, better illumination and smaller, less traumatic approaches seem to be advantageous [4,5]. Furthermore, minimally invasive techniques, such as endoscopy, are being used increasingly [6,7]. The goal of these techniques is to minimize the perineural trauma and to avoid epidural fibrosis. However, it still remains unclear if fibrosis really causes failure of therapy [8]. Currently, only few authors debate the necessity of removal of disc material from the

intervertebral disc space and the extent of discectomy [9–14].

The purpose of this study was to compare patients with lumbar disc herniation who were treated with discectomy and sequestrectomy as well as with sequestrectomy alone concerning their clinical outcome, pain, and disc reherniation.

Materials and Methods



Patient population

200 patients who harboured herniated lumbar discs refractory to at least 3 weeks of conservative treatment were included in this study. All patients were operated between January 2003 and September 2006 in the Department of Neurosurgery at the Wedau Hospital in Duisburg. 100 patients were treated by sequestrectomy

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alone (group 1). The second group consisted of another 100 consecutive patients undergoing both sequestrectomy and discectomy. Gathering of the discectomy patients was completed first. Within this time period, a total of 1245 patients underwent lumbar disc surgery. Thus, sequestrectomy alone was performed in 8% of all disc operations. Surgery was performed by 6 different surgeons, who did not differ significantly in their surgical skills.

A final decision regarding the appropriate surgical method (sequestrectomy vs. discectomy) was made intraoperatively. Patients with a large perforation at disc space (Carragee type 2) [15] and patients with intact annulus without fragments and contained herniations (Carragee type 4) underwent discectomy. In case of a minimal annular defect, a firm annulus, or a sequestered fragment (Carragee type 1) only sequestrectomy was performed without removal of material out of the intervertebral space. Fragment-contained herniations with intact annulus and subannular detached fragments (Carragee type 3) and soft discs underwent discectomy. In case of a firm annulus, only removal of the detached fragments was performed.

Informed consent was obtained by all patients preoperatively about the two different treatment modalities. The study was approved by the local ethics committee.

Inclusion criteria

All patients suffered from lumbar back pain and radicular pain resistant to at least 3 weeks of conservative treatment. MRI studies revealed disc herniation in all cases. Herniations could be free, subligamentary or transannular. Clinical symptoms were referable to a segmental level. All patients were proficient enough in the German language to complete the self-assessment questionnaires. If a patient met these inclusion criteria at admission, the patient was enrolled to this study, using the admission number.

Exclusion criteria

All patients undergoing a lateral spinal approach, with prior operation at the same level, significant spinal stenosis or articular cysts were excluded from this study. None of the patients underwent instrumentation for spondylolisthesis.

Clinical assessment

All patients underwent standardized neurological and clinical assessments, using the regional assessment formula of Nordsrhein for lumbar radiculopathy with 66 criteria [16]. Lower back pain and leg pain were documented separately preoperatively and at follow-up according to a self-assessment 10-point VAS [17]. The ODI (Oswestry low back pain disability questionnaire) gave a subjective percentage score of level of function (disability) in activities of daily living in those rehabilitating from low back pain [18, 19].

At discharge, the pain drugs were noted and coded from 0–3. one corresponded to a demand medication with muscle relaxant or non-steroidal antiphlogistic medication, two to a firm combined medication of these groups and three to an administration of opiates.

Surgical procedures

Surgery was performed under general anaesthesia in prone position and with the assistance of an operating microscope. In a standardized manner, the spinal canal was exposed by per-

Table 1 Demographical data.

| Parameter | Sequestrectomy | Discectomy | p value |
|---------------------------------|------------------|------------------|----------|
| numbers | 100 | 100 | |
| age \pm SD | 51.76 \pm 13.9 | 49.52 \pm 13.7 | n.s. |
| m/f | 64/36 | 50/50 | p = 0.04 |
| duration of symptoms (wks) | 6.26 | 6.03 | n. s. |
| duration of hospitalization (d) | 6.4 | 6.94 | p = 0.04 |
| follow-up (mo) | 34.1 | 35.4 | n. s. |
| follow-up (n) | 46 | 45 | n. s. |
| comorbidity (mean) | 0.67 | 0.39 | p = 0.02 |

forming an interlaminar fenestration. In cranially herniated discs only a translaminar approach was used.

In the discectomy group, the herniated disc was removed and the annulus fibrosus was incised, followed by removal of loose disc material from the intervertebral space by rongeurs.

In the sequestrectomy group, only the herniated material was removed without entering the disc space. In case of a small tear at the disc space and without extrusion of disc material under pressure with the dissector, the disc was only coagulated at the surface in order to reduce the bulging.

The location (cranial, caudal, at disc level) and the kind (free, subligamentary) of the herniated disc material and the presence and size of a tear at the disc space were documented. The morphology of disc herniation was then classified according to the 4-part system of Carragee [15]: type 1 fragment/fissure with minimal annular defect, type 2 fragment/defect with annular defect larger than 6 mm, type 3 fragment/contained without annular defect, and type 4 no fragment/contained without defect and without subannular detached fragment.

Statistical analysis

Spearman's correlation coefficients (r) were calculated. Non-parametric tests were performed because abnormal distributions were suggested by the normality tests of Kolmogorov-Smirnov. Normal distribution was only confirmed for the variables age and duration of follow-up. For these two variables the T-test was used. The non-parametric Mann-Whitney U test was applied to the other independent samples. For 2 dependent samples the Wilcoxon test was used. The χ^2 -test was calculated for comparison between nominal characteristics. A variance analysis (F-test) compared the mean values between groups. Probability values below 0.05 indicated a significant difference.

Results

The sequestrectomy-treated population was composed of 64 men and 36 women, whereas the gender distribution within the discectomy-treated group was equal (♂ Table 1). These intergroup differences were significant (χ^2 -test, $p = 0.04$). However, gender did not influence either the length of hospitalization, the consumption of painkillers, or the activity of daily routine. Only women suffered preoperatively from more intense back pain (U-test, $p = 0.03$), however, this difference could not be detected postoperatively.

Table 2 Clinical data preoperatively and at discharge.

| Parameter | Sequestrectomy | Discectomy | p value |
|-------------------------|----------------|------------|---------------------------|
| L2/3 | 8 | 2 | |
| L3/4 | 17 | 8 | |
| L4/5 | 45 | 33 | |
| L5/S1 | 27 | 57 | $p = 1.67 \times 10^{-4}$ |
| paresis pre/post | 55/21 | 26/4 | $p = 2.95 \times 10^{-5}$ |
| radicular pain pre/post | 100/0 | 100/1 | n.s. |
| back pain pre/post | 100/16 | 100/31 | $p = 0.01$ |

Table 3 Comorbidity and risk factors (number).

| | Sequestrectomy | Discectomy |
|------------------|----------------|------------|
| cardial | 6 | 8 |
| pulmonal | 3 | 1 |
| renal | 6 | 2 |
| neurological | 1 | 2 |
| hepatic | | 3 |
| hypertension | 22 | 17 |
| obesity | | 1 |
| diabetes | 8 | 2 |
| varicosis | | 3 |
| coagulopathy | 3 | 1 |
| endocrinological | 6 | 3 |
| GIT | 3 | 2 |
| others | | 3 |

The age distribution was similar in both groups (group 1: 51.76 ± 13.95 years, group 2: 49.52 ± 13.69 years) (• Table 1). The length of hospitalization was significantly lower in the sequestrectomy-treated group 1 (6.4 days vs. 6.94 days, U-Test, $p = 0.04$) despite the higher rate of comorbidities ($r = 0.28$, $p = 0.002$).

Past medical history

Five of the sequestrectomy-treated patients (group 1) and 11 of the discectomy-treated patients (group 2) had a prior history of lumbar discectomy at another level.

The number of comorbidities (• Table 3) was significantly higher in the sequestrectomy-treated group (mean 0.67 vs. 0.39, U-test $p = 0.02$). As expected, the number of comorbidities increased in both groups with age (group 1 $r = 0.39$, $p = 3.23 \times 10^{-5}$, group 2 $r = 0.5$, $p = 8.16 \times 10^{-9}$).

Signs and symptoms

The mean duration of symptoms was comparable in both groups (6.26 vs. 6.03 weeks). Preoperatively, there was one patient with bladder disturbance in the discectomy-treated group. 26 patients presented with paresis and 65 patients with sensory deficits. In the sequestrectomy-treated group, the number of sensory deficits was comparable ($n = 67$), whereas this group revealed a significantly higher number of paresis ($n = 55$, χ^2 -test, 2.95×10^{-5}) (• Table 2). Pain, assessment according to VAS, was comparable in both groups. Radicular pain was more prominent than back pain (• Table 5).

Postoperatively, 34 sequestrectomy-treated patients improved, 21 remained unchanged, whereas 22 in the discectomy-treated group improved and 4 remained unchanged. The postoperative improvement of paresis was significantly better in the discectomy-treated patients (χ^2 -test, $p = 2.78 \times 10^{-4}$). In the discectomy-treated group significantly more people ($n = 31$) complained of back pain at the time of discharge than in the sequestrectomy-treated group ($n = 16$; χ^2 -test, $p = 0.01$) (• Table 2). The firm consumption of painkillers (muscle relaxant and nonsteroidal antiphlogistic medication) was also significantly higher in the discectomy group (29 vs. 17 patients) (χ^2 -test, $p = 0.029$).

Surgery

L4/5 was the most frequently affected segment in the sequestrectomy group ($n = 45$), whereas L5/S1 ($n = 57$) dominated in the discectomy group (• Table 4) (χ^2 -test, $p = 1.67 \times 10^{-4}$). The F-test revealed an increasing affection of upper spinal levels with increasing age.

The disc material was herniated cranially in 56 patients and caudally in 44 patients undergoing sequestrectomy. In the discectomy group 2, cranial sequestration was found in 50, and caudal sequestration in 11 patients. In 39 patients of group 2 the disc material was located at the level of the intervertebral space (Carragee type 4) (• Table 4) (χ^2 -test, $p = 1.44 \times 10^{-13}$).

A small perforation of the annulus fibrosus was obviously present in 92 sequestrectomy patients (Carragee type 1). Only in 8 patients of the sequestrectomy patients and in 40 patients of the discectomy patients, could no tear be found (Carragee type 3).

In case of a large perforation a discectomy was performed. 21 discectomy patients revealed larger perforations (Carragee type 2) with extrusion of disc material under pressure (χ^2 -test, 4.2×10^{-24}) (• Table 4).

Complications

There were no intraoperative complications in both groups. One sequestrectomy-treated patient suffered postoperatively from an epidural haemorrhage and had to undergo reoperation on the fourth postoperative day with complete recovery.

Follow-up

Complete follow-ups including questionnaires and clinical examinations were available in 46 of the sequestrectomy patients with a median of 34.1 months, and in 45 of the discectomy patients with a median of 35.4 months (• Table 1).

There were no significant differences in the activities of daily life, measured by the Oswestry low back pain disability questionnaire. Only a tendency towards better results in the sequestrectomy group could be noticed (39.7% vs. 44.1%) (• Table 5). The VAS radicular pain scores were 2.6 and 3.3 for the sequestrectomy and discectomy groups, respectively ($p > 0.05$). Back pain was assessed more severely in both groups with a tendency to less pain in the sequestrectomy group (VAS scores 3.3 vs. 3.7, U-test n.s.) (• Fig. 1).

Recurrence

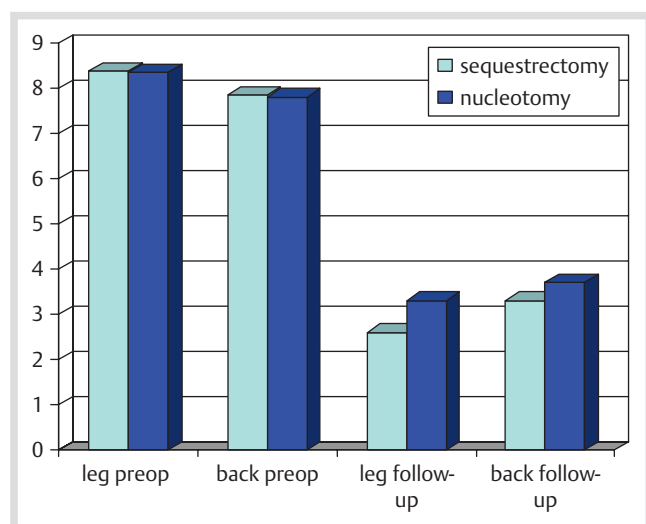
Two discectomy-treated patients required early reoperation for reherniation at the same intervertebral space. Both patients were reoperated on the third postoperative day with good recovery. In the sequestrectomy-treated group reoperation was performed in one patient after 31 months. None of the other patients underwent spine surgery at another level. One patient died due to cardiac failure.

Table 4 Comparison of intraoperative findings (numbers).

| | Sequestration | | Classification (according to Carragee [2]) | | | |
|----------------|---------------|--------|--|----|----|----|
| | Cranial | Caudal | 1 | 2 | 3 | 4 |
| sequestrectomy | 56 | 44 | 92 | 0 | 8 | 0 |
| discectomy | 50 | 11 | 0 | 21 | 40 | 39 |

Table 5 Comparison of VAS values and ODI results (mean values).

| | Preoperative | | Follow-up | | ODI % |
|----------------|--------------|----------|-----------|----------|-------|
| | VAS leg | VAS back | VAS leg | VAS back | |
| sequestrectomy | 8.39 | 7.86 | 2.6 | 3.3 | 39.74 |
| discectomy | 8.36 | 7.81 | 3.3 | 3.7 | 44.18 |

**Fig. 1** VAS scales for radicular and low back pain preoperatively and at follow-up.

Discussion

In 1978, Williams [20] reported a conservative microsurgical approach to herniated lumbar discs with removal of only the free fragments that compressed the nerve root. Furthermore, during this procedure the annulus was opened with extraction of free, loose fragments, while a curettage of the disc space was not performed. Williams reported a clinical success rate of 90%, and a recurrence rate of disc herniation of 4–9%. Other authors have confirmed these results [10,21–23]. Without extensive removal of intervertebral disc material the height of the disc space can be preserved, thus preventing loosening of ligaments and articular capsules. The latter, combined with reduced discal support in the anterior column, may result in segmental instability, facet arthrosis, and spondylosis [22]. Postoperative symptoms of epidural fibrosis, discogenic pain, spondylosis, arthrosis, and instability are summarized under “failed back surgery syndrome” [24]. This should be minimized by preservation of the disc and the physiological and normal anatomy. Especially younger patients with only mild degenerative changes and preserved disc height are expected to profit from this technique [25]. In 1995, Faulhauer and Manicke [10] published data on clinical courses after excision of only herniated fragments with a high success rate of 98%. The results are comparable with those

achieved after discectomy with success rates varying from 50 to 90% and recurrence rates ranging from 3 to 11% (Table 6). Only in a small retrospective study including 33 patients was a higher recurrence rate of 21% after sequestrectomy reported [13].

Clinical outcome

In the German quality assurance study of lumbar radiculopathy [16], pain improved after surgery from 87% to 3%, whereas the frequency of pain occurrence in the conservative group diminished only from 67% to 13%. 599 patients with local and radicular pain only suffered from local back pain postoperatively. Paresis improved from 46% to 21%. In the study of Wenger [22] success rates after the Williams [20] procedure for back pain were 92.5%, for radicular pain 94.7% and for neurological dysfunction 93.3%. In Thomé’s study [14], patient satisfaction showed a trend in favour of sequestrectomy. In our study, there were no differences in the activities of daily life. However, the follow-up with the ODI questionnaire was equally low (less than 50%) in both groups. Thus, these outcomes may not be representative for the whole group.

In the long-term study of standard discectomy of Yoimitsu et al. [26] 12.7% of patients complained about severe low back pain after more than 10 years. Patients with preserved disc height generally had more favourable results.

In our study, a trend towards a lower intensity of postoperative local and radicular pain could be seen after sequestrectomy. This went along with a lower consumption of painkillers and a shorter hospitalization time. These results may speak for an advantage of preservation of disc height. It seems to be likely that simple sequestrectomy can effectively treat an additional low back pain component. At follow-up, VAS scores for back pain were more favourable in our sequestrectomy-treated patients. Balderston et al. [9] noticed a lower incidence of back pain without curettage of the endplates. Thus, segmental degeneration was supposed to be slowed. Mochida et al. [25] confirmed that less aggressive removal of disc material may be associated with better radiographic and clinical results.

Preservation of potentially healthy disc tissue seems to be a simple and promising concept, regarding all the attempts of nucleus substitutes [23,27–30]. Especially younger patients with minimal degenerations could profit from preservation instead of removal of the disc. Furthermore, pain in these patients results from mass effect of the herniated disc and potential inflammatory reaction. Therefore, removal of the sequester should be a sufficient therapy. In our study, even elder patients with more comorbidities showed better results after sequestrectomy alone.

During the average 6 weeks of conservative preoperative treatment spontaneous healing or scarring of the annular rupture may have occurred. Avoiding a reopening of the annulus may prevent reherniation. As long as no loose disc material extruded under pressure out of the intervertebral space, the disc was left intact and only the herniated material was removed.

Recurrence

A frequent argument against exclusive sequestrectomy is the increased number of reherniations due to loose disc material and defects in the annulus [13]. Reherniation was found in 5–11% after standard discectomy [31–33]. Ipsilateral recurrence is more frequent than a contralateral one [34]. Williams [20] reported that 92% of reherniations occurred within the first 9

| Author | Year | Number | Discectomy | Williams | Sequestrectomy |
|-----------------|------|--------|------------|----------|----------------|
| Ebeling [36] | 1986 | 485 | 91.5 | | |
| Williams [20] | 1986 | 903 | | 86 | |
| Caspar [2] | 1991 | 299 | 92.1 | | |
| Striffeler [21] | 1991 | 56 | | 94.3 | |
| | | 51 | 90 | | |
| Balderston [9] | 1991 | 40 | | | 95 |
| Davis [37] | 1994 | 970 | 89 | | |
| Faulhauer [10] | 1995 | 100 | | | 98 |
| Lowell [38] | 1995 | 100 | 89 | | |
| Findlay [31] | 1998 | – | 91 < | | |
| Wenger [22] | 2001 | 104 | | 92.5 | |
| Thome [14] | 2005 | 84 | | | 92 |
| Kast [12] | 2005 | 174 | | < | 87 |
| Kast [39] | 2008 | 168 | 96.4 | | 96.7 |
| Thomé [40] | 2008 | 84 | 89.5 | | 87.5 |

Table 6 Review of literature and success rates (%) of different surgical procedures.

months after surgery, whereas Rogers [13] described a peak within 6 months. Five of the six reherniations in the study of Thomé et al. [14] also occurred during the first 6 months. Their reoperation rate of 10% after discectomy was higher than those reported by others. Kast et al. [12] and Faulhauer et al. [10] reported a rate of 1.3% and 2%, respectively. Other studies with limited discectomy and conservative intradiscal removal according to Williams found higher rates of 5.8% [22] and 3.7% [21]. In sequestrectomy-treated patients Thomé et al. [14] reported a reherniation in 5% within 12 to 18 months. However, in cases of large annular defect, subtotal discectomy is superior to fragment excision alone [11].

According to the literature, the earlier assumed lower probability of reherniation in case of more aggressive disc removal cannot be confirmed any more. Complete removal of the disc via a dorsal approach is not possible, because there is no distinct border between the rigid annulus and the soft nucleus and parts of these are left [11,35].

In our study, two early reherniations in the discectomy group and one late reherniation in the sequestrectomy group were seen. Our data provide some evidence that reherniations are not increased after sequestrectomy. However, in case of a soft annulus or a large defect a discectomy was performed. Only about 8% of all patients who underwent lumbar disc surgery met the criteria for sequestrectomy. Our strict selection may explain the low rate of reherniation. Furthermore, a secondary stabilization due to segmental instability was never necessary.

Conclusion

Sequestrectomy is a safe procedure and does not yield a higher incidence of reherniations compared with discectomy. There is a trend towards superior results after sequestrectomy. Especially for younger patients a sequestrectomy with preservation of the disc height should be preferred.

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